

counter electrode. The dedicated working and dual-role electrodes preferably have deposited thereon an assay reagent. The dual-role electrode is advantageously configured to operate first as the working electrode and then as the counter electrode. The assay reagent is preferably a binding reagent that is specific for an analyte of interest and may also be different for each of the dedicated working and dual-role electrodes.

[0010] Still further, the plurality of electrodes may be arranged within a flow cell, along the flow cell path. Preferably, the dedicated counter electrode is adjacent the dual-role electrode and the dual-role electrode is adjacent the dedicated working electrode. In addition, the plurality of electrodes are preferably arranged within a single detection chamber. The plurality of electrodes may comprise printed carbon ink. The dedicated working and dual-role electrodes may have assay reagents immobilized thereon within an assay domain defined by a dielectric layer.

[0011] The dedicated working, dual-role and dedicated counter electrodes preferably have corresponding electrical leads for supplying electrical energy to the electrodes. Preferably, at least two non-adjacent electrical leads would have an exposed surface located thereon. These exposed surfaces of the electrical leads preferably at least partially define an inlet conduit in fluid communication with a flow cell so that fluid present within the inlet conduit is in electrical contact with the exposed surfaces. In such a preferred embodiment, the exposed surfaces may be configured to apply an inlet conduit interrogation potential between exposed surfaces to determine the presence or composition of fluid in the inlet conduit. Additionally, the apparatus is preferably configured such that the applied interrogation potential between exposed surfaces is of insufficient magnitude to induce electrochemiluminescence at the corresponding electrodes.

[0012] In yet another embodiment, the apparatus can be configured with an optical detector for detecting luminescence generated at the dedicated working and dual-role electrodes. Alternatively, the apparatus may comprise a voltmeter for measuring potentials at the dedicated working and dual-role electrodes. In yet another alternative embodiment, the apparatus may comprise an ammeter for measuring electrical current at said dedicated working and dual-role electrodes. Preferably, the electrodes are housed in a disposable assay cartridge and the optical detector(s), voltmeter(s), and/or ammeter(s) are housed in a separate re-usable cartridge reader.

[0013] In accordance with another aspect of the invention, a cartridge for conducting a plurality of assays may comprise a flow cell having an inlet, outlet and a detection chamber. The detection chamber preferably comprises a plurality of electrodes arranged in a one dimensional array wherein at least a first electrode has a first assay reagent immobilized thereon. According to certain preferred embodiments, the electrodes may comprise carbon ink. The electrodes preferably have a plurality of electrical leads that supply electrical energy to the electrodes. In addition, the cartridge may comprise a second electrode arranged adjacent to the first electrode, the second electrode preferably having a second assay reagent immobilized thereon.

[0014] According to one embodiment, the cartridge preferably has a detection chamber with at least one detection

chamber surface. Preferably, at least a portion of the detection chamber surface would be transparent. Still further, the cartridge may comprise an optical detector adapted and arranged to detect luminescence from the detection chamber. Preferably, the optical detector is provided in a separate cartridge reader.

[0015] In accordance with another aspect of the invention, a method is disclosed for conducting an electrochemiluminescence measurement wherein impedance is measured between two electrodes and wherein electrochemiluminescence is induced at one of the two electrodes. The impedance is measured between the two electrodes in a measurement chamber to detect the presence of air bubbles. The impedance measurement step is preferably conducted using electrical energy that is insufficient for generating electrochemiluminescence at the electrodes. Additionally, the impedance measurement may be conducted using either a DC impedance measurement or, more preferably, an AC impedance measurement.

[0016] According to yet another aspect of the invention, a method of depositing assay reagents on an electrode surface, preferably comprising carbon ink, to form an assay domain is disclosed. The method comprises the steps of dispensing a predetermined volume of the assay reagents on the electrode surface using impact-driven fluid spreading to coat a predefined region having a predefined assay reagent area on the electrode surface. The predetermined volume of said assay reagents is preferably dispensed at a velocity greater than 200 centimeter per second (cm/s). Preferably the predefined assay reagent area is larger than the steady-state spreading area of the predetermined volume of the assay reagents on the electrode surface. More preferably the predefined assay reagent area is at least twice the steady-state spreading area of the predetermined volume of the assay reagents on the electrode surface. The method would preferably use a fluid dispenser utilizing using a fluid micro-dispenser such as a micro-pipette, micro-syringe, solenoid valve dispenser, piezo-driven dispenser, ink-jet printer, bubble jet printer, etc. Also, the assay reagents are preferably substantially free from surfactants.

[0017] According to one embodiment, the electrode surface preferably comprises a material having advancing and retreating contact angles for the assay reagents (preferably, aqueous solutions having contact angles that approximate that of water) that differ. More preferably, this difference is at least 10 degrees. The electrode surface need not be plasma treated. Additionally, the predefined region is preferably defined by a dielectric material having dielectric advancing and retreating contact angles for the assay reagents. The dielectric retreating contact angle is preferably greater than the electrode surface retreating contact angle. More preferably, the dielectric advancing and retreating contact angles are about equal to each other but greater (preferably, by more than 10 degrees) than the electrode surface retreating contact angle. Most preferably, the dielectric advancing and retreating contact angles are within about 20 degrees of each other. Also, the predetermined volume may preferably be selected such that any assay reagents that spread onto the dielectric material retreat to an interface between the dielectric material and the electrode surface that defines the predefined region.

[0018] A further aspect of the invention relates to a method of adsorbing assay reagents on a carbon ink elec-